

PRESCRIPTION FIRE TO MANAGE SOUTHERN PINE PLANTATIONS – DAMNED IF YOU DO, DAMNED IF YOU DON'T

Dale Wade and Ken Outcalt
Research Forester and research Ecologist
USDA Forest Service, Southern Research Station
Athens, GA 30602

ABSTRACT

This paper discusses some ramifications of using herbicides in place of prescription fire on southern pine plantations. The historic role of fire in the South and its use by industrial foresters is briefly recounted. Reasons are given for the shift by industry, from leaders in advocating and using prescription fire to its almost total replacement by herbicides in plantation management during the past several decades. The 1998 Florida wildfires are used to examine the dependence of the timber loss on stand-tending treatments and on the elapsed time since application. We suggest industry reconsider its decision to exclude prescribed fire in plantation management. Not because it is a necessary silvicultural treatment, but as insurance against plantation loss and because it will make nearby residents feel more secure about the safety of their property during future wildfires.

INTRODUCTION

The 4 major southern pine species (loblolly, longleaf, shortleaf, and slash) are pyrogenic. They evolved under a regime of chronic fire and developed adaptations that favor them over broadleaf plant species. Fire frequency varied, as did intensity. Depending upon moisture conditions at the time of the fire, all but the wettest and driest sites burned several times a decade with low- to medium- intensity fires. This fire regime recycled nutrients and top-killed invading hardwoods. It consumed accumulated pine needles and understory herbs. The result was a species-rich herbaceous groundcover that facilitated fire spread thereby strengthening this feedback loop.

In the absence of fire, a dense woody understory rapidly forms (within 3 to 4 years on mesic sites). The herbaceous plant component is shaded out by the rank growth of hardwoods and flammable shrubs which, along with the developing duff layer, prevent pine regeneration. For the first decade or two, potential fire intensity increases with each passing year until equilibrium is approached between dead fuel accumulation and decomposition. Moreover, the increasing needle drape and stature of volatile understory shrubs such as palmetto, gallberry and wax-myrtle provide a dangerous fuel complex that acts as a ladder to bring flames and heat into overstory pine crowns. If the inevitable wildfires are all suppressed, hardwoods will eventually take over as the pine overstory dies of old age, or from lightning strikes and associated insect infestations.

PRESCRIBED FIRE HISTORY

When European colonists arrived in the southern United States more than 4 centuries ago, they quickly adopted the Native American practice of using fire to: keep the forest open, reduce pests, promote fruiting of desired plants, and improve game-species habitat. In addition, the colonists used fire to increase the amount and palatability of forage for the cattle they had brought with them. By the beginning of the twentieth century, most areas were burned at least every 1 to 2 years, primarily to protect turpentine orchards from wildfire, to facilitate hunting, and to "green up" the native range. Only longleaf regeneration could survive under such a fire regime, but feral hogs uprooted most longleaf seedlings to dine on the starchy taproot. Thus, as the virgin forests were harvested, sites remained devoid of trees. Then the bole weevil, coupled with the depression of the 1930's resulted in widespread agricultural abandonment. Real estate prices crashed and many lands were forfeited for non-payment of taxes. At the same time, however, states were implementing the federally mandated policy of fire exclusion and passing fence laws. Because the South is blessed with warm temperatures and abundant rain, the end result was that much

of this acreage returned to pine, especially loblolly and slash which seeded in from their wetter refugia. These two species were also widely planted to arrest erosion under various government programs such as the Civilian Conservation Corps.

The wood industry recognized this opportunity and began an extensive land-buying program. With the sharp increase in demand for southern pine products after World War II, these activities intensified. The hardwood encroachment problem remained however, although it took longer to manifest itself on abandoned agricultural lands. As industry invested more money, losses to wildfire and competition from understory brush and hardwoods received more attention. The fallacy of complete fire exclusion was recognized by most southern states and the laws changed to allow the use of intentional fire, particularly to reduce the buildup of hazardous fuel loads. Industrial foresters embraced its use for this purpose, as well as to control hardwood encroachment into pine stands. Industrial use of prescription fire peaked in the nineteen seventies when industry accounted for a significant share of the roughly 2+ million hectares of forestland treated each year in the South.

Dormant-season backfires were the treatment of choice and were extensively used for hazard reduction. Backing fires, however, take much longer to execute than heading or flanking fires. Furthermore, prescription burns require a narrow set of weather conditions, which cannot be accurately forecast more than a few days in advance. To ensure stands selected for burning in annual plans were treated, previously scheduled tasks had to be delayed and burning given top priority whenever acceptable weather conditions materialized. As companies concentrated on fiber production for pulp and paper, they switched to short-rotation plantation management. This necessitated placing increased emphasis on planning, as the importance of timely completion of scheduled tasks became paramount to running the operation at close to optimum efficiency. Keeping escalating labor and equipment costs in check required more coordination between tasks. And conducting planned burns was one of the most difficult tasks to coordinate and complete in a timely fashion because of its dependence upon the weather. With the advent of aerial ignition, industry was able to decrease the per-acre cost of burning while dramatically increasing the acreage treated in a given day; This greatly reduced the number of days burning impacted other scheduled tasks.

Fire was also used between rotations, often in conjunction with heavy equipment to dispose of logging debris and prepare sites for reforestation. If these burns were not conducted when planned, planting had to be delayed for a year thereby throwing the overall management plan off schedule. Land lying fallow does not make money for shareholders. Opportunities to shorten rotations and reduce overall costs were seized. In fact, considerable effort was devoted to developing improved/alternative stand-tending practices such as herbicides and fertilization.

As state agencies became more proficient at detecting and suppressing wildfires, companies relied more on the states for suppression, and in many cases did not replace expensive fire-fighting equipment. As rotation age continued to drop, the risk of chance wildfires also decreased, although the value of the crop at risk increased.

THE SHIFT TO HERBICIDES

Pulp and Paper companies have long worked with chemical manufactures to perfect the use of herbicides for the control of unwanted plant species. Early on, herbicides had a bad reputation from an environmental standpoint because of some mistakes in application, effects on non-target species, publication of the book *Silent Spring*, and from the ramifications of their use in Viet Nam. They none-the-less largely replaced the use of heavy equipment for site preparation, often in conjunction with prescribed fire, the combination being called "brown and burn". Over the years improvements in their specificity, safety and application, along with strict regulation has propelled them to the tool of choice for vegetation control. Their cost per acre is, however, about 10 times that of prescription fire, they actually increase fire hazard for a year or two following application, and they do not reduce buildup of the forest floor. So why have herbicides replaced fire?

Major constraints to the use of fire include its unpredictability; the effects of fire on recently fertilized stands; compliance with internal, local, state and federal guidelines and statutes; and the specter of litigation. The correct application of fire requires skill and extensive training, but is still as much an art as it is science. Although the ability to predict fire behavior grows with experience, regulating the rate of combustion is a complex process where

small differences can have major repercussions. Ignoring or not being aware of a change in just one of the scores of burn parameters, a mistake in execution of the burn, or unexpected sudden changes in the weather can all rapidly compromise the safety of personnel. Furthermore, any fire can escape from its planned boundaries with potentially devastating results to both people and the resource. Slight miscalculations when conducting a burn can also result in on-site resource damage. For example, The use of aerial ignition results in most of the area treated, being burned by heading and flanking fires. Such fires tend to have higher fireline-intensities than backing fires and are thus more likely to result in crown scorch which reduces tree growth; the more foliage scorched, the greater the growth loss. Some crown scorch is associated with virtually every large burn because they generally encompass a wide variety of microsites and fuel conditions.

Numerous studies have addressed the effects of fire on nutrient cycling. Although some nitrogen is volatilized in the combustion process, the amount of nitrogen available for plant uptake increases, and the overall effect of burning on sandy soils of the Atlantic Coastal Plain appears to be positive [1]. Nitrogen is generally limiting on these sites, however, so fertilizer is often applied to industrial plantations a year or two after crown closure. Burning too soon after fertilizing will result in substantial nitrogen volatilization negating much of the desired growth effect. For that reason, most companies wait five years after applying fertilizer before underburning. As rotation age drops closer to 15 years, the use of fire after the application of mid-rotation fertilizer becomes more problematic. On some ownerships, prescription fire is not used simply because the chemical process used to make certain products cannot tolerate char. The easiest way to avoid any problems is to not use fire.

Disposal of post-harvest debris has also changed. This material was traditionally pushed into windrows and burned. Piling was necessary to ensure larger-diameter material ignited and was consumed, but these windrows would often smolder for weeks creating significant nighttime smoke problems. As companies plant their 3rd tree crop on the same site, larger cull material is no longer present, and as smaller-diameter materials are utilized, there is less material to dispose of before replanting, negating the need for piling.

The southeast is also a retirement mecca. For example, about 1,000 people per week have been immigrating to Florida for the past several decades, mostly from the urban north. Many of these people are retirees with respiratory problems that are aggravated by wood smoke. They have pushed the urban-wildland interface right up to industrial plantations in many areas. These people have lost their ancestral ties with fire, and have to be educated to the benefits of fire in fire-adapted ecosystems. They don't like the inconvenience of smoke related delays/detours on roadways and have little tolerance for the smell of smoke in and around their homes or ash in their swimming pools. The populace in general is also becoming more litigious and the wood industry is perceived as having "deep pockets". In all too many cases, companies have been singled out and held liable for nighttime smoke-related accidents in spite of evidence to the contrary, or in situations they had no control over such as sudden unforecast changes in wind direction.

Another constraint to using fire is the effort required to plan and execute prescription fires within the framework of proliferating statutes, regulations and guidelines at all levels of government, some of which can be in conflict with each other (e.g.; the Endangered Species Act and The Clean Air Act). Florida leads the nation in the number of hectares burned by prescription, typically treating close to 800,000 a year. Because Florida is truly fire country, all 33 counties in North Florida and 15 of the 26 in Central Florida have passed ordinances stating that the use of prescription fire is a property owner right. But people and smoke do not mix well. The Florida Division of Forestry thus has the unenviable task of promoting and facilitating the use of prescription fire, while at the same time enforcing applicable state statutes and regulations, and protecting public health and welfare. To help in this latter regard, the state requires a daily permit for all burns on forestlands and will turn down requests under some weather and operational situations.

Forest industry has found using herbicides a valuable alternative with advantages over fire. In the first place the above prescription fire related problems all disappear. The wildfire problem still exists (the south records about 50% of all wildfires in the contiguous US), but the average wildfire size in the south is only about 2 hectares, due mainly to the effectiveness of state fire control agencies. Of course it is the damage done and not the acreage burned that is important. The use of herbicides in lieu of prescribed burning does predispose plantations to higher levels of damage during extended droughts because the developing duff layer, and the roots within it are consumed.

At most other times, however, moisture in the duff layer will prevent it from burning and the reduced stature of the understory will markedly reduce flame lengths and thus fireline-intensity. Intensity is, however, likely to be increased from the time of chemical application until the dead stems fall to the ground. Thus the effect of herbicide treatment on fire behavior depends upon the time since application and dead fuel moisture conditions at that time. Another advantage of herbicides is that the effects of any application problems are likely to remain on-site minimizing potential litigation, while the deleterious effects from fire and smoke often occur off-site.

THE 1998 FLORIDA WILDFIRES

The wildfires that ravaged Florida during the summer of 1998 were uncommon but not unprecedented and they will happen again in the future. Severe drought set the stage and heavy lightning activity with little accompanying rain provided the ignition source. Over 2,250 wildfires burned 202,000 hectares in the seven-week period starting June 1, about 25% of the total on forest industry land. Jefferson Smurfit, one of the large timber companies in the area, lost less than 5,000 hectares, but the cost of the timber crop, site preparation, and reforestation of these sites will be approximately 6 million dollars. They spent an additional \$300,000 fighting these fires on both their own and adjoining lands, none of which they will be receive compensation for.

One question that has been repeatedly asked in the wake of these fires is whether the periodic use of fire on industry lands would have made a difference? An on-going research study involving the authors will provide quantitative details, but based on discussions with firefighters, the answer will be mixed from a suppression standpoint. Firefighters referred to plantations where herbicides had been applied within the last year or two as "kerosene forests" because they observed substantial increases in fireline-intensity as fires entered such stands. On the other hand, firefighters noticed reductions in fireline-intensity where herbicide had been applied several years earlier because of the decreased stature of the understory. Firefighters did report several instances where they were able to make progress on the flanks of a wildfire or force it to veer off in a new direction in stands that were regularly prescribed burned. But unless an area had been burned within the last year or so, firefighters were unable to stop the head on those days with more severe burning conditions. Thus, we doubt the lack of prescription fire on industry lands played a significant role in the extent of these fires, although the number of fire brands would have been considerably reduced. An analysis done on the Osceola National Forest in the late fifties showed that fires were significantly larger where the age of the rough was five or more years [2]. I see no reason that the same trend should not hold true for herbicide-treated areas as well.

The effects on crop tree damage are, however, another matter. On high fire-danger days, even stands that had been burned within the past year suffered appreciable crown scorch, but on lower fire-danger days, crown damage was considerably less. We think the study mentioned above will show substantial differences in direct tree mortality between stands treated with herbicide and those treated with prescribed fire. Periodic fire keeps a duff layer from developing while herbicides have little effect. After 3 to 4 years, pine feeder-roots begin to colonize the developing duff layer, so that any fire that consumes an appreciable amount of this layer will result in root mortality. Southern pines generally survive complete defoliation as long as the buds are not damaged, but these species are susceptible to root damage. Although a substantial number of trees have refoliated, their future is questionable. Bark beetle populations typically explode after such catastrophic fires (as they are now doing) with tree mortality increasing in stands stressed by both crown and root damage.

PUBLIC ATTITUDE AND FIRE POLICY

As you can imagine, both the public, and fire management professionals have focused attention on fire issues in the wake of the Florida wildfires. People who previously opposed the use of fire are now believers, especially those who have seen first-hand, the contrast in wildfire damage between homes where adjacent hazardous wildland fuels had been recently reduced through the use of prescription fire and where fuels had been left untreated. Many of these people now mistakenly believe forest industry contributed significantly to the disaster by not using prescribed fire to reduce the fuel buildup in their plantations. It's ironic that the complaints and litigation pertaining to prescribed fires from these same people were contributing factors in industries decision to abandon the practice. Industry is

damned if they do and damned if they don't. The problem now is that people think prescription fire can be used to minimize the threat of damaging wildfire in every situation. Elected politicians, aware of this interest, are eager to show their electorates that they are responsive to this issue. They have worked with the state Division of Forestry to introduce legislation favorable to fire management that will likely pass the legislature this spring. The Division itself has also proposed rule changes in its regulations that will benefit certified prescribed burners. Perhaps the most important is legislation to give certified prescribed burners more liability protection when they follow Best Management Practices but unforeseen circumstances beyond their control result in a bad outcome.

At the national level, changes have been underway for several years. Both the Departments of Interior and Agriculture are aggressively promoting the increased use of fire, and instituting changes to facilitate its use. The Environmental Protection Agency is in the process of issuing new guidelines pertaining to particulate matter which treat fire as a natural occurrence and recognize that we are better off intentionally using fire under selected weather conditions rather than leaving ignition and direction of spread up to chance.

The periodic intentional use of fire can help resource managers meet many objectives in fire-adapted plant communities from increased biodiversity to reduced fuel hazard. But this by no means implies that fire should be used on all ownerships under all situations. Intensively managed southern pine plantations are just one example. A strong case can be made for treating such stands as an agricultural crop. In fact they are sometimes called fiber farms. And like other crops, fire can destroy them. I believe it should be left up to the owner to decide whether a crop should be protected from unwanted fire. If owners choose not to, however, they must also accept the consequences. On some industrial lands in central Florida, plantations that were a year away from being large enough to salvage were wiped out in 1985 and again in 1998 because quick suppression by the state, rather than fuel reduction was relied on to protect the investment. The only practical way to reduce the accumulation of hazardous fuels is the use of periodic fire. If government provides an atmosphere conducive to the judicious use of fire, many more landowners, including industry are likely to reconsider its use. The use of fire in industrial plantations will not be for any silvicultural benefit but as insurance against loss of the plantation from wildfire. Given the current favorable public attitude about the use of prescription fire for hazard reduction, nearby landowners would be less likely to blame industry for any property loss due to wildfire.

If the wood industry decided to expand the use of prescription fire on their lands, how would that impact the present situation? Using northeast Florida as an example, the three largest timber companies together own more than 162,000 hectares of planted pines over 14-years old. Assuming a 4-year burning interval (which is really too long for aerial ignition) and 20 days of acceptable burning weather during the dormant season each year, these three ownerships alone would burn 2,025 hectares on each of the 20 days. The several national and state forests, state parks, smaller timber companies and myriad of small nonindustrial forest landowners in the vicinity would all also want to burn on these same days. One can envision the smoke impacts.

Fire managers are optimistic regarding these emerging signs of an overall public attitude more conducive to the use of fire. They hope it lasts but they also must take care not to oversell the benefits of prescription fire. Regardless of the level of prescribed fire use, there will continue to be damaging wildfires, and they will occasionally be on the scale of the Florida wildfires of 1998, but damage will be reduced on areas that are periodically burned.

SUMMARY

Southern pines are fire-adapted. Humans have used fire to achieve numerous objectives for centuries. Industry advocated and extensively used fire on its lands for several decades, especially to control unwanted vegetation. Because of numerous problems associated with the use of fire such as the potential for deleterious effects on- and off- site, coupled with improvements in herbicide specificity and safety, southern pulp and paper companies have switched to herbicides to control broadleaved vegetation. Unlike prescribed fire, however, herbicides have little effect on the buildup of dead fuels. Although the average wildfire size is about 2 hectares in most southern states, occasional drought-related fire episodes occur, such as the 1998 Florida wildfires. These fires consume large

amounts of the forest floor along with pine feeder roots that have colonized the duff layer. Periodic use of fire prevents development of a duff layer. The result is substantially risk of increased crop-tree mortality from wildfires in herbicide-treated stands as compared to stands treated with prescription fire.

Public attitude regarding the use of prescription fire is much more favorable in the wake of the Florida wildfires and is being translated into changes in policy and statutes that facilitate the use of fire. Assuming these changes come about, we suggest industry reconsider the use of fire in plantation management. Not because it is a necessary silvicultural treatment, but as insurance against plantation loss and because its use will make nearby residents less likely to blame industry for any loss of property from wildfire.

REFERENCES

- 1 McKee, W.H.Jr. 1982. Changes in soil fertility following prescribed burning on coastal plain pine sites. Research Paper SE-234, Asheville, NC: USDA Forest Service, Southeastern Forest Experiment Station. 23 pp.
- 2 Davis, L.S. and Cooper, R.W. 19963. How prescribed burning affects wildfire occurrence. *Journal of Forestry* 61(12):915-917.

ACKNOWLEDGEMENT

The data pertaining to Jefferson Smurfit was provided by Mike Branch, a regional manager with that company located in Fernandina Beach, FL.